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Successful Aging in Oldest-Old Adults: Role of Physical and Social Factors

Katie Elizabeth Stanko
Louisiana State University and Agricultural and Mechanical College, kstank1@lsu.edu

SUCCESSFUL AGING IN OLDEST-OLD ADULTS: ROLE OF PHYSICAL AND SOCIAL FACTORS

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In dedication to my favorite successful ager: my grandmother, Virginia Mae Rainey (1924-2014), who inspired me to have a career in gerontology. Her spirit was imperative for the motivation to design and complete this thesis.

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The Louisiana Healthy Aging Study (LHAS) is an interinstitutional, multidisciplinary study of the determinants of longevity and healthy aging in oldest-old adults. The LHAS is a collaborative effort with behavioral and medical researchers from Louisiana State University (LSU) in Baton Rouge, LSU Health Sciences Center in New Orleans, Pennington Biomedical Research Center (PBRC), the University of Pittsburgh, and the University of Alabama at Birmingham. I thank the LHAS researchers, staff, and participants for their efforts which have resulted in a rich dataset. I also thank S. Michal Jazwinski for making these data available to me for use in the current project.

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ABSTRACT

Successful aging, increasing in chronological age while maintaining health, is related to a multitude of factors including social and physical behaviors. Older adults may report that they are aging successfully while biomedical outcomes suggest otherwise. In the present study, sociodemographic characteristics, social engagement, physical activity in relation to frailty and health-related quality of life (HR QoL) were examined using a lifespan sample of adults (N = 732) from the Louisiana Healthy Aging Study (LHAS). Four age groups were compared: younger (21-44 years), middle-aged (45-64 years), older (65-84 years), and oldest-old adults (85 to 101 years). A main effect of age was found for both subjective and objective indices of health, with oldest-old adults reporting lowest health and highest frailty; older and oldest-old women were in significantly poorer health and had higher levels of frailty than their male counterparts. Two regression models, one with a subjective health and objective health outcome, were conducted. In model 1, physical activity, hours out of the home, and frailty score were significant contributors to subjective health. In model 2, age, gender, level of education, hours out of the home, and presence of a confidant or close person were all significantly associated with frailty score. Together these findings indicate both physical activity and social support and engagement impact how older adults view themselves aging as well as objective, biomedical outcomes of successful aging.

INTRODUCTION

When an infant is born, parents may ponder what trajectory their child's life will take, including his or her successful and healthy development. Three children born at the exact spatiotemporal location as one another can have vastly different health and lifespans: one may die of a heart attack in middle age, while the other two survive well into later adulthood and become nonagenarians or even centenarians. Determining the causes and antecedent conditions that foster healthy and successful aging is a critical challenge for researchers. Importantly, there is also a societal urgency for doing so. By the year 2050, an estimated 83.7 million adults in the United States will be 65 years or older, nearly doubling its approximated 2012 population (Administration on Aging, 2015). Specifically, the "oldest-old" (persons 85 years of age and older) are the fastest growing segment of the population (Ortman, Velkoff, & Hogan, 2014) , while also being the most vulnerable cohort in regards to terminal age-related diseases (Heron, 2016). Given this demographic reality and impending costs of indirect and direct healthcare, basic research on the determinants of successful aging is a timely imperative (see: Pruchno, Wilson-Genderson, Rose, & Cartwright, 2010; Rowe & Kahn, 2015).

While the desired "Fountain of Youth" remains a myth, aging successfully can be a reality if healthcare practitioners and the general public is made aware of the components needed. Therefore, in the sections that follow, current demographics and mortality rates of older adults are discussed first. Next, theoretical approaches and factors empirically shown to be related to successful aging are presented. By measuring across multiple domains of health such as biological, emotional, physical, and social support, a holistic view of the multiple variables important for one to successfully age can be revealed.

Demographics and Mortality

One of the hallmarks of a developed country is a low mortality rate and an increase in average lifespan across generations. The United States has demonstrated this exponential trend especially in the post-World War II era. People born between 1946 and 1964 are known affectionately by society as "the baby boomers." This was the first generation to have spending and economic power as teenagers (Owram, 1997). As they continue to age, Baby Boomers are redefining what has been traditionally labeled as "older adulthood" in mass quantities. In 2003, the 65+ population was 35.9 million; by 2013, that number had increased 24.7% to 44.7 million and is expected to more than double that amount to 98 million older adults by 2060 (Administration of Aging, 2015). While the youngest members of the demographic were expanding to greater proportions than ever before, concerns for the older population started to grow: by 1950, the population aged 65+ had more than doubled since the beginning of the 20th century, and over 60% were living in poverty while less than half owned health insurance. Thus, in 1965 under President Lyndon B. Johnson, Medicare and Medicaid were enacted as Title XVIII and Title XIX of the Social Security Act, providing hospital, post-hospital extended care, and home health coverage to almost all Americans aged 65 or older (Medicare & Medicaid Milestones, 2015). While empirical research has failed to find a significant effect of Medicare on mortality before and after implementation (e.g., Finkelstein & McKnight, 2008), other research has shown a sharp decrease in acute terminal illness such as massive heart attacks before and after implementation that did not occur in non-Medicare countries in that same time period (Chay, Swaminathan, & Kim, 2010).

Even as the number of older adults living well into their eighties and beyond increases, not all of these older adults are aging healthily or successfully. The top five causes of death in

the United States for those over 65 include cardiovascular disease, cerebrovascular disease (e.g., stroke, aneurysm), and neurodegenerative disease such as Parkinson's disease, Alzheimer's disease, and dementia (Heron, 2016). In 1900, the top three causes of death for Americans 65 and older were influenza and pneumonia, tuberculosis, and diarrhea and enteritis, accounting for 31% of the total causes of death. Due to developments in medicine and sanitation, these diseases now account for less than 3% of older adult deaths. Instead, as of 2014, heart disease, cancer, and Chronic Obstructive Pulmonary Disease (COPD), the top three current causes of death, accounted for over half (53.5%) of the total causes of death (National Center for Health Statistics, 2016). Negative health and lifestyle behaviors such as smoking, obesity, and sedentary activity contribute to the current top three causes of death. Therefore, while influenza, tuberculosis, and diarrhea now have cures and treatments for a reactive approach once one is diagnosed, there is no one immediate cure for diseases of the heart, cancer, and COPD. Rather, it may be best to have a preventive approach, educating people across the lifespan on the factors that lead to and prevent these illnesses.

The fourth and fifth top age-related causes of death, cerebrovascular disease and Alzheimer's disease, are more difficult to have a proactive or reactive approach to curtailing. While some lifestyle behaviors such as smoking has demonstrated an increased risk of stroke (e.g., Shinton & Beevers, 1989), their sudden and often unpredicted onset can be fatal. Furthermore, in each decade over 50 the risk of stroke doubles (Panel et al., 1997). Lastly, Alzheimer's disease (AD) affects approximately 5.3 million adults age 65+ (Hebert, Weuve, Scherr, & Evans, 2013), with the oldest-old (85+) being most affected (Heron, 2016). It is estimated the oldest-old population will expand from 5.6 million in 2012 to nearly 18 million in 2050 (Ortman, Velkoff, & Hogan, 2014), and it is further predicted that 7 million, or 38% of this

subpopulation, will have and eventually die from complications from AD. A nursing home placement often occurs in the later stages of dementia and dementia-related illnesses, where unhealthy aging is often exacerbated by overwhelmed and undertrained staff (e.g, Cohen-Mansfield & Mintzer, 2005). Challenging behaviors seen among older persons with dementia are often managed pharmacologically. Louisiana currently has the highest rate of anti-psychotic use in nursing facilities (Centers for Medicare and Medicaid Services, 2015). Strategies to reduce the reliance on antipsychotic medications coupled with interventions to promote quality of life are important challenges for senior service providers and those in the nursing home industry. Determining how some people manage to avoid these terminal illnesses while others succumb has been an interest to scholars for many years, leading to the birth of the field of successful aging. To illustrate, a chart depicting seminal successful aging research appears in Figure 1 below.

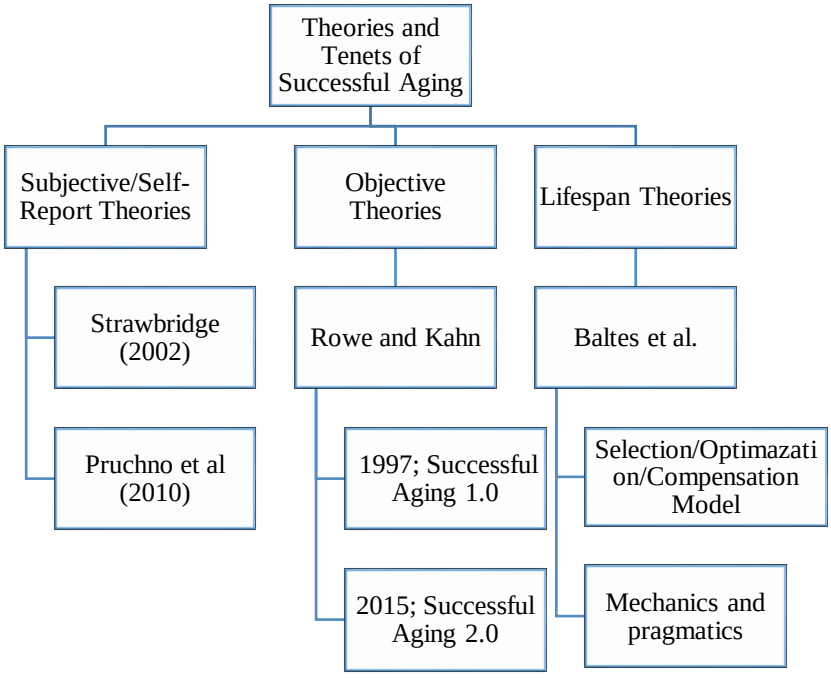


Figure 1: Successful Aging Research Overview

Theoretical Approaches to Successful Aging

Rowe and Kahn (1997; 2015) have conceptualized successful aging as encompassing low level of disease/disease-related disability, relatively high cognitive and physical function, and continued engagement in social and everyday life activities. From this perspective, successful aging is a reflection of healthspan mortality as opposed to absolute lifespan mortality (Lithgow, Lord, & Kirkland, 2012). Healthspan is defined as the length of time one lives in optimal health without being majorly affected by age-related pathologies. Ideally, one's healthspan would overlap his or her lifespan in that all years lived, even in older age, are encompassed by low disease/illness, high cognitive and physical functioning, and continued social engagement. However, using an objective, health-centric measure of successful aging severely limits those who would otherwise describe themselves as successfully aging. For example, Strawbridge, Wallhagen, and Cohen (2002) examined self-reports of older adults aging successfully compared to those who were aging successfully according to Rowe and Kahn's operationalized definition. While only 18.8% of their sample would be classified as successful aging from Rowe and Kahn's perspective, 50.3% of the sample self-reported that they believed they were aging successfully. Strawbridge et al.'s findings, among others, attest to the need to broaden Rowe and Kahn's criteria to include subjective measures of well-being in later life (see Cherry, Marks, Benedetto, Sullivan, & Barker, 2013, for discussion).

While the general public may have an idea if they themselves are aging successfully or not, gerontologists have yet to reach consensus of what qualifies as "successful aging." Baltes and Carstensen (1996) proposed a more *process-based* approach to successful aging rather than *outcome-based***.** That is, they argued that successful aging should not be defined by emphasizing gains, such as what Rowe and Kahn (1997) proposed, but rather how an individual adapts to

losses such as disease and cognitive decline. Rowe and Kahn's (1987) original definition of successful aging reflects a medical model in that they had stated *no* rather than *low* levels of disease, which excluded many older adults even if they did not feel their disease did not interfere with their quality of life. Successful aging, as Baltes and Carstensen proposed, should not be based upon normative goals and ideals, but rather entail a broader definition in which multiple outcomes are measured using various assessment criteria (e.g., subjective vs. objective) and a variety of different norms. In addition, successful aging and gerontological researchers encompass a multitude of disciplines, such as psychology, public health, kinesiology, etc. to provide the most holistic view of the components longevity; the Gerontological Society of America prides itself on displaying and promoting international collaboration between biologists, health professionals, policymakers, and behavioral social scientists.

In their *selection-optimization-compensation* (SOC) (Baltes & Baltes, 1990) model, successful aging occurs when a person continues to reach goals they consider important, using strategies to adapt to losses caused by aging. This shifts the definition of successful aging from "overall good physical health" to "personal meaning in life." Specifically, "success" is defined as personal goal attainment, while "successful aging" is defined as minimization of losses and maximization of gains (Baltes & Carstensen, 1996). This is achieved through three processes: selection, optimization, and compensation. Selection can be a preventive measure for or a reaction to increasing restrictions in various areas of life usually caused by losses in old age, such as increasing frailty, memory loss, etc. One older adult may select to reduce amount of activities involved in, while another may downsize their home and relocate closer to adult children. Consistent modification of individual goals is at the core of selection.

Optimization, the second item in SOC, occurs when older adults choose to enrich and continually develop their selected domains, known as generativity, or invest in new areas that will assist them with developmental tasks in older adulthood, such as coming to terms with one's own mortality. The last factor of the SOC model, compensation, involves modifying behavior and use of strategies to assist in areas where losses have occurred. An older adult using a hearing aid is an example of compensation via technological advances. In a four year longitudinal study, Lang, Rieckmann, and Baltes (2002) found that older adults who were high in sensorimotor, cognitive, and social and personality resources invested more time in social activities with family and reduced diversity in their dominant leisure domain (e.g., physical leisure, social leisure, intellectual/cultural leisure) than those scoring lower in those resource areas. The successful agers, those who both scored highest on the resource measures and survived across the four year study, had used *selection* to choose which activities were important to them, *compensated* for age-related fatigue by taking daytime naps, and *optimized* their performance by mastering or becoming deeply involved in the selected areas. All three factors of the SOC model are very dependent upon the individual's personal goals; thus, a greater number of older adults are classified as "successfully aging" using this model of successful aging rather than Rowe and Kahn's (1987; 1997). In an Editorial in *The Journal of Gerontology*, Rowe and Kahn (2015) addressed these concerns with their original model, saying that their model better addressed the *what* of successful aging while more lifespan, process-based models such as SOC (Baltes & Baltes, 1990) answered the *how* of successful aging.

As displayed in Figure 1, successful aging has shown evidence for both objective (e.g., health-related) and subjective (e.g., self-report and self-appraisal) factors. Pruchno and colleagues (2010) investigated health-related differences amongst four groups of older adults: 1)

people who were successfully aging according to both subjective and objective criteria, 2) those who were successfully aging according only to subjective criteria, 3) people who were successfully aging only under objective criteria, and lastly, 4) people who were *not* successfully aging according to both subjective and objective criteria. For subjective measures of success, they asked participants three questions about how they personally felt they were aging. Objective success was operationalized as maintaining functional ability, having little physical/bodily pain, and having few chronic conditions. Compared to the Successful agers (groups 1-3), the Unsuccessful agers (group 4) reported significantly less social support. This difference was also observed when comparing subjective-only successful agers (group 2) and objective-only successful agers (group 3) with those who were successful according to both criterion (group 1). Compared to the objective only group, the subjective only group reported significantly more social support. Expanding upon prior literature, their study provided evidence for a successful aging model that encompasses multiple dimensions measured by both objective and subjective factors (cf. Strawbridge et al., 2002). In addition, evidence was found for role of social support and engagement in moderating an individual's appraisal of their quality of life in older adulthood (Pruchno, Wilson-Genderson, Rose, & Cartwright, 2010).

Social Factors, Physical Health, and Successful Aging

Cherry, Walker et al. (2013) investigated age and gender differences in social engagement, positive health behaviors (e.g., refraining from tobacco and alcohol use), and physical health in a study of healthy aging that included very old adults. Social engagement was operationalized as using a) level of perceived social support, b) presence of a confidant, and c) number of social activities and hours spent outside of the home. Physical health was measured via the Short Form 36 (SF-36) (Ware & Sherbourne, 1992; Ware et al., 1995; Ware, 2000), a

self-report, domain-specific measure of health-related quality of life (see Appendix C, page 44), and objective health status based upon an index of six chronic conditions: high cholesterol, hypertension, diabetes, arthritis, heart problems, and cancer. These conditions ranged in severity from mild/moderate (e.g., high cholesterol and arthritis) to more severe (e.g., heart problems and cancer), and were selected to provide a broad assessment of health. For each participant, scores of 0 (absence) and 1 (presence) were assigned for each health condition and summed to create a cumulative, composite index of health (range: 0 to 6), with higher scores indicating greater comorbidities. Originally designed to meet the needs of the Medical Outcome Survey, a large-scale population-based study, the SF-36 contains 36 health-related quality of life items spread across eight scales: physical functioning, role limitations due to physical problems, social problems, bodily pain, general mental health, role limitations due to emotional problems, vitality, and general health perceptions. These eight scales can also be collapsed across one another to form a Mental Health Composite Score (MCS) and Physical Health Composite Score (PCS). MCS and PCS are two summary measures that reduce Type I error risk in running multiple comparisons in hypothesis testing (Ware et al., 1995). The MCS is comprised of the mental health, emotional role limitation, and social functioning subscales. The PCS contains the physical functioning, physical role limitation, and social functioning subscales. The remaining two subscales, vitality and general health, have correlations with both MCS and PCS components. Using these two composite scores (MCS and PCS, respectively) reduces the number of required hypothesis testing to 32 (2 composites multiplied by 16 tests) from 128 (8 domains multiplied by 16 tests (Ware, Kosinski, Bayliss, McHorney, Rogers , & Raczek, 1995). Validity of the three-level taxonomy (36 individual items, 8 domains, and two composite scores) has been demonstrated by many researchers (c.f., Ware, 2000) as well as validity across diverse

populations (e.g., McHorney, Ware, Lu, & Sherbourne, 1994). In older adults, large population based studies have demonstrated both internal consistency and validity for use amongst older adults (e.g., Lyons, Perry, & Littlepage, 1994; Walters, Munro, & Brazier, 2001). Its ease of distribution and assessment in conjunction with high construct validity and test-retest reliability have made it one of the most popular health-related quality of life psychometric tests, with over 25,000 publications utilizing it since 1988 (Google Scholar).

The second aim of their study concerned predictors of physical health using measures of social engagement, positive health behaviors, and both subjective and objective criteria. Regression analyses indicated that age, gender, and social engagement (specifically hours spent outside of the house) were associated with self-reported health as indexed by the SF-36 PCS scores. Social engagement (measured by hours spent outside of the home) was significantly associated with both physical health dimensions (objective and self-reported) after age, gender, and demographic factors were entered into the model. For objective health status, the contribution of both social engagement indices (hours outside of the home and the number of clubs and social organizations) remained significant after controlling for age, gender, and demographic factors. Hence, the higher levels of social engagement a person reported, the higher both their subjective and objective health ratings were, indicating importance of socialization at the end of the lifespan. Wang et al. reported similar results in Chinese nonagenarians and centenarians, displaying ecological validity in successful aging across Western and Eastern cultures (Wang et al., 2015).

Frailty

Recent attempts to quantify successful aging have come in the form of frailty indices. Frailty is described as a phenotype which presents itself as lower functional reserve and

physiologic dysregulation that results in a lowered ability and capacity to manage destabilizing stress (Kim & Jazwinski, 2015). The frailty phenotype was first described by Fried and colleagues (2001) as the presence of at least three of five structural and functional deficits in an individual: unexplained weight loss, exhaustion and fatigue, muscle weakness, slow gait, and little to no physical activity. A frailty index is a way to further quantify and operationalize this phenotype. Researchers create frailty indices by gathering common health deficits related to frailty, such as BMI, chronic conditions, and inability to perform short physical tasks. By using a frailty index comprised of 34 health-related variables (FI-34) with the LHAS population (*N*=869), Kim and Jazwinski (2015) demonstrated a high correlation and non-linear increase in the rate of deficits with increasing age (at the population level). At the individual level, FI-34 can increase, decrease, or remain the same over three to five years. In comparisons, the FI-34 was a better indicator of healthspan than chronological again; essentially, it measures an individual's biological age. See Appendix A (page 51) for all health-related variables included in this index.

Physical Activity

Assessing levels of physical activity is crucial for successful aging researchers as continued maintenance of health and independence are reliant upon level of physical functioning. In a clinical trial, Pahor et al. (2014) provided sedentary older adults who had physical limitations an intervention of structured, moderate physical activity. This regimen consisted of aerobic, resistance, and strength training exercises done twice a week at a medical center and three to four times a week at home. Across 2.6 years, participants who were assigned to the exercise condition over a health education program were less likely to report acute and persistent mobility disability, defined as inability to perform a 400m walk, a commonly used metric of

physical functioning in older adults. While empirical evidence demonstrates that even moderate physical activity can beneficial to health, well-being, risk of disability, across the world, older adults are not meeting recommended physical activity guidelines. Using a sample of 230 elderly residents of the UK, Davis et al. (2011) found only 3 participants met the required physical activity levels for health maintenance; in the United States using the National Health and Nutritional Examination Study (NHANES), Troiano et al. (2008) found only 2.4% of the sample aged 60+ was meeting the recommended physical activity level. The former studies used accelerometry, measuring patterns of movements and activity through a pedometer that the participant wears.

Through accelerometry an objective measure of physical activity is obtained. In situations where an accelerometer is unavailable, physical activity questionnaires are given for participants to self-report their level of activity. One of these measures is the Yale Physical Activity Survey (YPAS) (Dipietro, Caspersen, Ostfeld, & Nadel, 1993), an assessment of physical activity specifically validated for use with older adults. The first section of the YPAS (Appendix B) is used to calculate a weekly energy expenditure value (EE). Participants are asked to report how many hours they spend doing activities under the categories of house work, yard work, caregiving, exercise, and recreation. The minutes per week one spends doing a specific activity is multiplied by an intensity code, and all values are then totaled across activities to create a weekly EE expressed in $kcal/wk^{-1}$. By using a survey questionnaire, a subjective view of physical activity is provided.

As successful aging has many contributing factors, multiple domains of health and health-related quality of life must be measured. In the present research, subjective physical health was measured via self-report (SF-36 PCS) and frailty scores (FI-34), an objective measure

of health. Additionally, estimated level of physical activity was achieved via the energy expenditure measure of the YPAS, mental/health cognition measured via the Mini-Mental Status Examination (MMSE) (Folstein, Folstein, & McHugh, 1975) and Geriatric Depression Scale (GDS) (Sheikh & Yesavage, 1986), and level of social engagement using the same questions used in Cherry et al. (2013). Taken together, these dependent measures provide a more comprehensive assessment than in previous research (e.g., Cherry, Walker, et al., 2013). Additionally, the present study has used a wider age range than earlier studies to provide new information on oldest-old adults, the fastest growing segment of the older adult population in the United States.

FOCUS OF THE PRESENT RESEARCH

The present research was designed to address two issues with respect to the study of successful aging in oldest-old adults. The first aim of this study was to examine age group and gender differences in sociodemographic characteristics (cognitive and affective status, self-reported health, and educational attainment), physical and social activities, and frailty. This study extended Cherry, Walker, et al.'s (2013) earlier work in three ways. First, sampling occurred from a broader range of cognitive status scores (i.e., MMSE of 24 and higher) resulting in a larger sample (n = 732) which we partitioned into four age groups: younger (21 to 44 years), middle-aged (45 to 64 years), older (65 to 84 years), and oldest-old adults (85 + years). By doing so, this study allowed for clearer inferences on health in midlife than in Cherry, Walker, et al. (2013) where younger and middle-aged adults were combined. Based on prior literature, significant age group (Cherry et al., 2013) and gender differences (Cherry, Silva Brown, Kim, Jazwinski, 2016) in self-reported physical health were expected. Additionally, a 34-variable frailty index as a measure of physical frailty (FI-34; Table 1) was included, which expanded Cherry et al.'s (2013) six chronic illness measure of objective health. Importantly, the FI-34 has been validated and provides a more comprehensive assessment of physical well-being than in earlier work. Significant age group differences in frailty were also expected, based on earlier findings (Kim & Jazwinski, 2015).

The second aim of this study was to address predictors of both subjective and objective health in two respective models. In Model 1, SF-36 PCS scores were used as an index of subjective health-related quality of life. Based on prior research, we expected that social factors and physical activity would be significantly associated with SF-36 PCS scores after considering key sociodemographic characteristics (age, gender, level of education). Whether social factors

account for unique variance after statistically controlling for sociodemographic, physical activity, and the FI-34 frailty metric was unclear. Finding that social engagement variables account for significant variance would suggest that social factors still matter to health outcomes after taking physical activity and frailty into account. This outcome would confirm the beneficial effects of both social engagement and physical activity for successful aging in later life (Rowe & Kahn, 1997; Pruchno et al, 2010).

Because the SF-36 PCS is a self-report, subjective measure of quality of life and well-being, regression analyses with the FI-34 as the outcome variable and sociodemographics, physical activity, and social engagement and support as predictor variables were carried out. Thus, in Model 2, FI-34 scores served as the outcome variable as well as an objective, quantifiable measure of biologic age. Finding significance in these models would indicate the importance of physical activity and social environment as protective factors against degree of frailty.

METHOD

Participants

A total of 732 participants, who ranged in age from 21 to 101 years were sampled from the Louisiana Healthy Aging Study (LHAS), a multidisciplinary study of the determinants of longevity and healthy aging in oldest-old adults. The LHAS is a collaborative effort with behavioral and medical researchers from Louisiana State University (LSU) in Baton Rouge, LSU Health Sciences Center in New Orleans, Pennington Biomedical Research Center (PBRC), the University of Pittsburgh, and the University of Alabama at Birmingham.

LHAS participants lived within an eight parish (county) area which spanned a 40-mile radius of Baton Rouge. Participants were recruited through random sampling of voter registration lists and the Center for Medicare and Medicaid Services files by personnel in the School of Public Health at the LSU Health Sciences Center in New Orleans. Information about the LHAS was mailed out to potential participants with a self-addressed, stamped envelope and postcard to return to indicate their interest in participating.

Those who returned their postcards were contacted for a pre-visit at the PBRC where informed consent was obtained and physiological and psychological measures were obtained. For those older than 70 years, this preliminary assessment was solicited in a home visit. Next, a day-long session was held at the PBRC where participants completed multiple measures of physical and psychosocial functionality. A nurse from the PBRC, as well as faculty and graduate students from the LSU Department of Psychology (Baton Rouge), collected physiological and psychological measures from each LHAS participant.

All participants were paid at least $50 for their voluntary participation. The procedures used were reviewed and approved by the Institutional Review Boards of the participating

institutions. All participants scored 24 or higher on the Mini-Mental Status Examination (MMSE) (in line with Tombaugh & McIntyre, 1992), a screen used to assess cognitive impairment.

Predictor Variables (Independent Variables)

Social engagement was operationalized by: a) the number of clubs and social organizations a participant belongs to; b) number of hours per week spent outside of the home; c) satisfaction with social support received for dealing with day to day problems; and d) whether they had a confidant, described as someone they can talk to about issues that concern them, after Cherry, Walker, et al. (2013).

The Yale Physical Activity Survey (YPAS) is self-report measure designed to measure daily physical activity specifically in older adults. The YPAS contains three summary measures that have been validated for individual use, including total energy expenditure (EE) (Dipietro, Caspersen, Ostfeld, & Nadel, 1993). In this study, we utilized the Yale total energy expenditure subscale score which reflects a sum of time spent on various activities multiplied by an intensity code, after Kim et al. (2012).

Outcome Variables (Dependent Measures)

SF-36 PCS scores. Self-reported measures of health were taken via the Medical Outcomes Survey (MOS) Short Form-36 (SF-36) (Ware & Sherbourne, 1992). In this study, we specifically used the SF-36 Physical Health Composite Score (PCS). The SF-36 PCS scores range from 0-100 and have been normed, signaling 50 as the mean. A score of 0 indicates the lowest possible quality of life while 100 is the highest quality of life.

FI-34 Frailty Index. As discussed previously, frailty indices provide a quantifiable view of a person's biologic age. The entire FI-34 index and individual items are located in Appendix A (pg. 42). A frailty ratio ranging from 0 (no deficits reported) to 1 (all 34 deficits reported) is then calculated for each participant.

Statistical Analyses

All statistical analyses were conducted using IBM SPSS version 24.0 statistical software. Means and standard deviations are reported for all continuous variables. Frequencies and percentages (%) are reported for categorical variables. To address the first aim of this study, one-way ANOVAs were run to investigate age (categorized by group: young, middle-aged, older, and oldest-old), gender, and their interaction effect on social engagement, physical activity, and frailty. Correlations were also run to demonstrate associations among these variables. For the second aim, separate multiple regression analyses were carried out for the SF-36 PCS and FI-34 scores. In Model 1, sociodemographic characteristics, social engagement, physical activity, and frailty index scores served as predictors for the subjective outcome variable, self-reported health (SF-36 PCS). In Model 2, sociodemographic characteristics, social engagement, physical activity were predictors for the objective outcome, degree of frailty (FI-34). This analysis plan was justified because the independent variables were predictor variables that we assumed have some degree of correlation amongst one another. This method is also justified because we had a priori hypotheses about which predictors may influence the model more than others. In each of these regressions, age, gender, and education were entered first, in order to account for these sociodemographic variables before considering the predictors of central interest.

RESULTS

Analyses of Age and Gender Differences

Sociodemographic characteristics for all participants are reported in Table 1 (page 27), including cognitive status (assessed with the Mini-Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975); affective status (assessed with the Geriatric Depression Scale (GDS; Sheikh & Yesavage, 1986), educational attainment, and self-rated health. Table 2 (page 29) presents self-reported health and objective health status. An ANOVA on the SF-36 PCS scores yielded significant main effects of age group, F (3, 724) = 54.36, $p < 0.01$ and gender, F (1, 724) = 13.57, $p < 0.01$. As predicted, scores decreased significantly across each of the age groups. The Age Group x Gender interaction effect was also significant, F (3, 724) = 5.31, $p = 0.01$. Follow-up comparisons confirmed a statistically significant gender difference for the older ($p < 0.01$) and oldest-old adults ($p < 0.01$) and but not for the younger ($p = 0.73$) or middle-aged adults ($p = 0.86$), as the means in Table 2 (upper panel) suggest. There was a significant association between age group and education level, χ^2 (18) = 69.37, $p < 0.01$, and gender, χ^2 (6) = 17.07, $p = 0.01$. The oldest-old group reported significantly lower levels of education ($p < 0.01$) than the other three groups which were not different amongst themselves. As predicted, a significant main effect of age group on measures of affective status, Geriatric Depression Scale (GDS; Sheikh & Yesavage, 1986), F (3,722) = 6.32, $p < 0.01$ and the MMSE screen for cognitive health (Tombaugh & McIntyre, 1992), F (3,724) = 101.68, $p < 0.01$ was shown. A gender effect was also found to be a significant for GDS, F (1,722) = 4.98, $p = 0.03$; females reported higher scores than males on this measure. An ANOVA on the Yale Total Energy Expenditure, the measure of physical activity, revealed significant main effects of age group, F (3, 724) = 27.29, $p < 0.01$ and gender, F (1, 724) = 6.77, $p = 0.01$.

Table 1: Sociodemographic and Individual Difference Characteristics (N = 732)

	Younger adults (21-44 years) n = 191	Middle-aged adults (45-64 years) n = 196	Older adults (65-84years) n = 134	Oldest-old adults (85 years +) n = 211
		M (SD)		
Age	34.7 (6.4)	52.8 (4.9)	74.4 (5.2)	91.2 (2.5)
Cognitive status[a]	29.5 (1.0)	29.2 (1.1)	28.7 (1.4)	27.3 (1.7)
Affective status[b]	1.9 (2.4)	1.7 (2.4)	1.5 (1.6)	2.5 (2.3)
Physical activity (YPAS)[c]	8408.5 (6441.9)	7012.1 (4959.5)	6534.2 (4509.9)	3633.2 (3052.1)
		N (%)		
Sex (female)	133 (69.6%)	115 (58.7%)	74 (55.2%)	122 (57.8%)
Education				
< 7th grade	0 (0.0%)	0(0.0%)	1 (0.7%)	5 (2.4%)
7th to 9th grade	1 (0.5%)	1 (0.5%)	4 (3.0%)	19 (9.0%)
10^{th} to 11th grade	4 (2.1%)	2 (1.0%)	4 (3.0%)	15 (7.1%)
High school or GED equivalent	35 (18.3%)	48 (24.6%)	38 (28.3%)	46 (21.8%)
Partial college or training	64 (33.5%)	64 (32.8%)	37 (27.6%)	64 (30.3%)
College degree	67 (35.1%)	49 (25.1%)	31 (23.1%)	40 (19.0%)
Graduate degree	20 (10.5%)	31 (15.9%)	19 (14.2%)	22 (10.4%)
Clubs and social organizations				
None	42 (21.9%)	36 (18.4%)	6 (4.5%)	23 (10.9%)
Between 1 and 3	138 (72.3%)	139 (70.9%)	99 (73.9%)	153 (72.5%)
Between 4 and 6	11 (5.8%)	13 (6.6%)	22 (16.4%)	28 (13.3%)

(Table 1, continued)

More than 6	0(0.0%)	8 (4.1%)	7 (5.2%)	7 (3.3%)
Number of hours per week outside of home				
None	3 (1.6%)	1 (0.5%)	1 (0.7%)	13 (6.2%)
Between 1 and 5	10 (5.2%)	12 (6.2%)	29 (21.6%)	67 (31.7%)
Between 6 and 12	25 (13.1%)	29 (14.9%)	33 (24.6%)	65 (30.8%)
Between 13 and 19	23 (12.0%)	26 (13.2%)	27 (20.5%)	27 (12.8%)
More than 19	130 (68.1%)	127 (65.1%)	44 (32.8%)	39 (18.5%)
Social support				
Very satisfied	96 (50.5%)	93 (48.2%)	105 (78.3%)	176 (83.4%)
Fairly satisfied	69 (36.3%)	75 (38.9%)	25 (18.7%)	30 (14.2%)
A little satisfied	18 (9.5%)	19 (9.8%)	3 (2.2%)	4 (1.9%)
Not satisfied	7 (3.7%)	6 (3.1%)	1 (0.7%)	1(0.5%)
Confidant (yes)	182 (95.3%)	183 (93.4%)	123 (91.8%)	182 (86.3%)

Notes. [a]Mini-Mental State Exam (Folstein, Folstein, & McHugh, 1975). [b]Geriatric Depression Scale (Sheikh & Yesavage, 1986). [c]YPAS total energy expenditure score expressed as kilocalories per week.

Table 2: Dimensions of Physical Health by Age Group and Gender

Variables	Younger adults (21-44 years)	Middle-aged adults (45-64 years)	Older adults (65-84 years)	Oldest-old adults (85 years +)
	Means (Standard Deviations)			
SF-36 PCS[a]				
Males	51.13 (8.40)	49.19 (9.10)	46.81 (8.28)	42.82 (10.01)
Females	51.58 (8.12)	48.96 (9.29)	41.83 (11.00)	36.79 (10.87)
Total	51.44 (8.19)	49.06 (9.19)	44.06 (10.15)	39.34 (10.91)
Frailty Index Ratio[b]				
Males	0.06 (0.03)	0.10 (0.06)	0.18 (0.07)	0.18 (0.07)
Females	0.07 (0.04)	0.11 (0.06)	0.19 (0.08)	0.24 (0.09)
Total	0.07 (0.04)	0.105 (0.06)	0.19 (0.08)	0.22 (0.09)

Notes. Entries are means and standard deviations. [a]SF-36 physical health composite score (Ware et al., 2002). [b]Frailty Index 34; number represents ratio of diagnosed illnesses to undiagnosed per individual (Kim & Jazwinski, 2015). Both measures used the full-sample size of 732.

As with the SF-36 PCS scores, each increasing age group reported less physical activity than the age group before it. A significant Age Group x Gender interaction, F (3, 724) = 2.85, p = 0.04, was demonstrated, and pairwise comparisons displayed that in the youngest (p = .01) and middle-aged groups (p = .03), females reported significantly more physical activity than males, but no significant difference between the oldest two groups were found.

Number of social organizations was found to have a significant association with age group, χ^2 (3) = 50.40 $p < 0.01$ (Figure 2, pg. 24). Interestingly, this significance was due to younger adults reporting less than expected clubs and activities, while older-old adults contributed significantly more. Analyses of hours spent outside of the home revealed significant main effects of age group, χ^2 (12) = 176.33 $p < 0.01$ with the oldest group reporting the least amount of time spent outside the home, followed by the older group (Figure 3, pg. 25). A gender effect was displayed, χ^2 (4) = 13.71 p = 0.01, which favored males. Satisfaction with social support revealed a main effect of age group, χ^2 (9) = 90.63 $p < 0.01$, with older and oldest-old adults reporting higher satisfaction than the younger and middle-aged adults (Figure 4, pg. 26). For presence of a close person or confidant, age group was significant, χ^2 (3) = 11.49 p = 0.01, as the oldest-old group reported not having a confidant more often than the younger two age groups (p = 0.01 and p = 0.05, respectively).

For objective health status, analyses of the FI-34 frailty index yielded a significant effect age group, F (3, 724) = 181.89, $p < 0.01$, and gender, F (1, 724) = 16.02, $p < 0.01$. Corrected postdoc comparisons, revealed significant descending levels of frailty among all four groups, with the oldest-old group reporting significantly more deficits than the three younger groups ($p <$ 0.01). An Age Group x Gender interaction was observed, F (3,724) = 5.37, p = 0.01, where the oldest-old group's males reported less frailty than females did ($p < 0.01$).

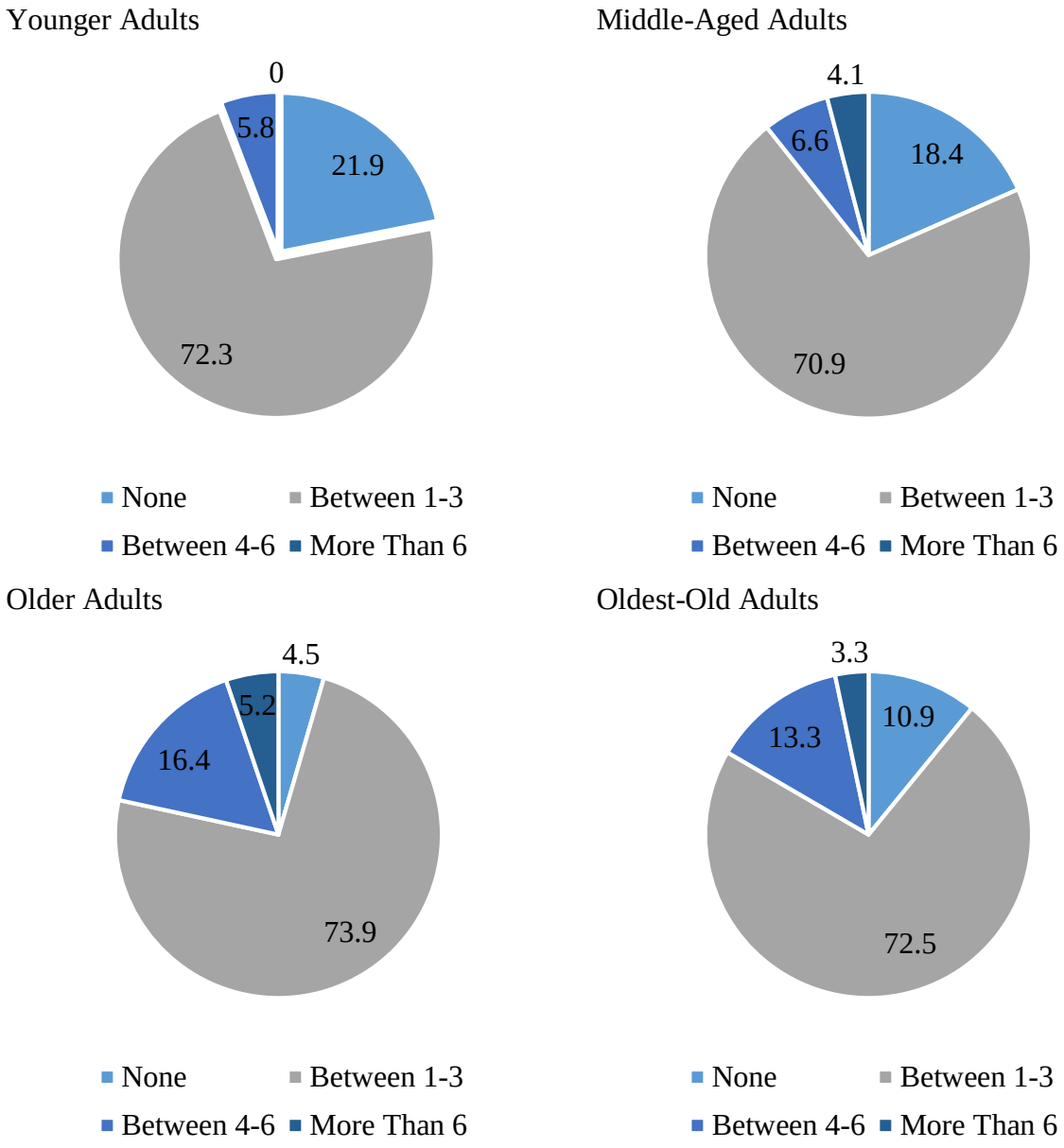
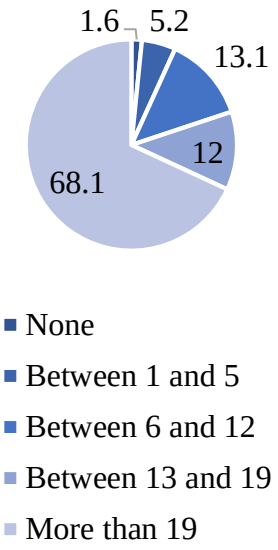
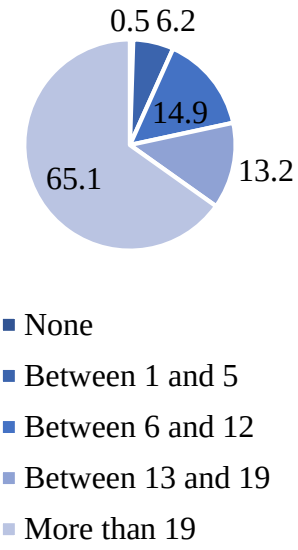


Figure 2: Number of Clubs or Social Organizations Belonged to by Age Group

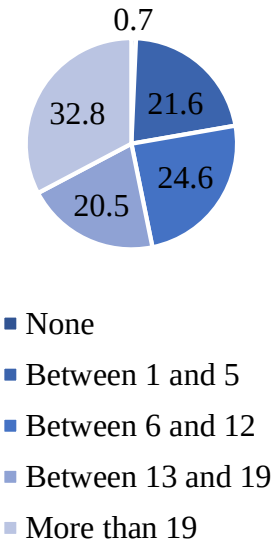
Younger Adults



Middle-Aged Adults



Older Adults



Oldest-Old Adults

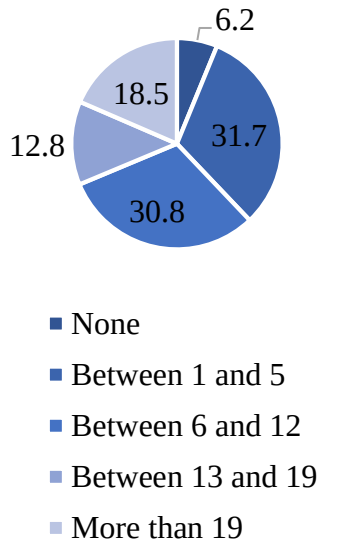


Figure 3: Number of Hours per Week Spent Out of Home by Age Group

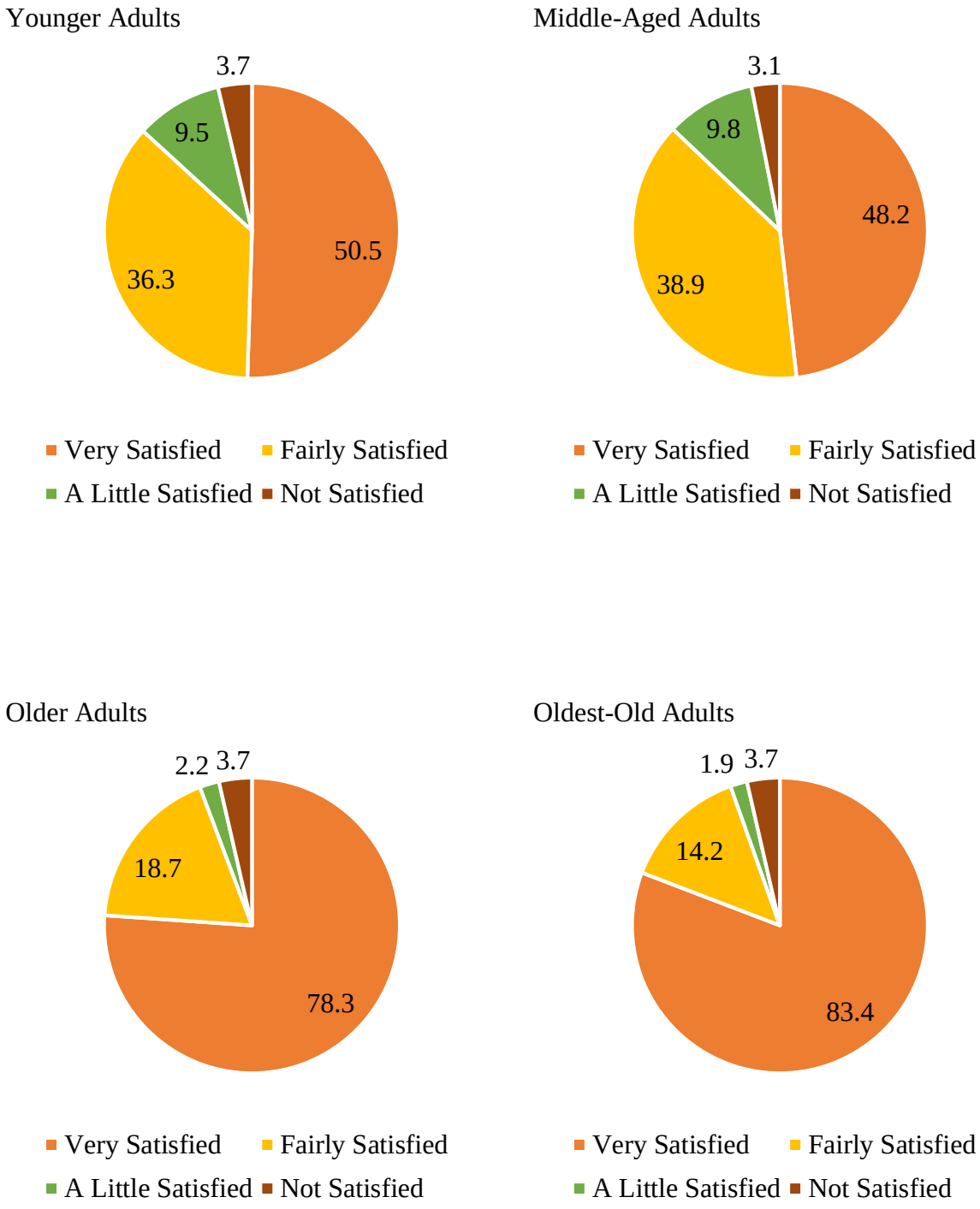


Figure 4: Satisfaction with Social Support by Age Group

Table 3: Bivariate Correlations Amongst Variables (Pearson's)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age Group	-												
2. Sex	-.088*	-											
3. Education Level	-.207**	-.088*	-										
4. Mini-Mental Status Examination (MMSE)	-.526**	0.052	.284**	-									
5. Geriatric Depression Score (GDS)	.096**	.083*	-.220**	-.147**	-								
6. Vocabulary	-0.040	-0.059	.517**	.361**	-.173**	-							
7. SF-36 PCS	-.447**	-.086*	.199**	.304**	-.388**	.123**	-						
8. Number of clubs or social organizations	.182**	-0.068	.181**	-0.068	-.194**	.128**	-0.050	-					
9. Hours spent outside of the home	-.452**	-.123**	.223**	.353**	-.219**	.214**	.377**	0.049	-				
10. Satisfaction with support received	.298**	-0.040	-0.044	-.144**	-.288**	0.001	-0.033	.130**	-0.055	-			
11. Presence of a close person or confidant	-.123**	0.016	0.014	0.072	-.129**	-0.057	0.070	0.040	0.065	.107**	-		
12. Yale Physical Activity Survey (YPAS)	-.340**	.116**	0.061	.232**	-.137**	-0.052	.254**	-0.021	.205**	-.116**	0.049	-	
13. Frailty Index 34 (FI-34)	.660**	0.059	-.215**	-.399**	.281**	-.112**	-.636**	.114**	-.438**	.094*	-.147**	-.263**	-

*Correlation significant at $p < 0.05$

**Correlation significant at $p < 0.01$

Bivariate correlation analyses (see Table 3, page 35) revealed lower level of education was found to associate with higher frailty scores, $r = -.215$, $p < 0.01$. Higher scores on the Geriatric Depression Scale (GDS) were found to relate with higher levels of frailty, $r = .281$, $p < 0.01$, while higher scores on the Mini-Mental Status Examination (MMSE) led to lower degree of frailty, $r = -.399$, $p < 0.01$. Number of clubs or activities was also shown to relate to frailty, $r = .114$, $p = 0.002$. Hours out of the home was inversely related with FI-34 score, $r = -.438$, $p < 0.01$. There were no more significant age group or gender effects found in this analysis.

Multiple Regression Analyses

SF-36 PCS scores (Subjective Health). Table 4 reveals that age, gender, and education accounted for a significant 22.8% of the variance in the self-reported health responses, $F(3, 722) = 70.94$, $p < 0.01$ (Model 1). After adding physical activity to the model, the demographic variables remained significant. Physical activity also made a significant contribution ($p < 0.01$) in support of the hypothesis. Totaled, these variables accounted for 24.2% of the variance, $F(4, 721) = 57.70$, $p < 0.01$ (Model 2). After adding the four social factors (number of clubs and activities, hours spent outside the home, presence of a confidant or close person, satisfaction with support received), the demographic and physical activity variables held their significance, although only hours spent outside of the home ($p < 0.01$) and satisfaction with social support ($p = 0.01$) made significant contributions; number of social organizations was not found to be significant to the model ($p = 0.31$) nor was presence of a confidant or close person ($p = 0.76$). Together, these variables accounted for 27.5% of the variance, $F(8, 717) = 34.02$, $p < 0.01$ (Model 3). Crucially, these data strongly support the hypothesis that social factors still impact physical health even after physical activity has been taken into account. Lastly, a final model was constructed with the aforementioned variables plus the inclusion of the measure of objective

Table 4: Multiple Regression Models with Self-Reported Health as Criterion Variable

Health outcomes	Unstandardized coefficients		Standardized coefficients		
	B	SE B	β	*P*	R^2
Physical health composite (SF-36 PCS)					
Model 1 (Demographics)					22.8%
Age	-4.06	.31	-.44	.00	
Gender	-2.71	.73	-.12	.00	
Education	.85	.29	.10	.00	
Model 2 (Demographics, Physical Activity)					24.2%
Age	-3.66	.33	-.39	.00	
Gender	-2.96	.73	-.13	.00	
Education	.85	.29	.10	.00	
Physical activity (YPAS) [a]	.00	.00	.13	.00	
Model 3 (Demographics, Physical Activity, Social Factors)					27.5%
Age	-3.18	.38	-.34	.00	
Gender	-2.36	.72	-.11	.00	
Education	.74	.29	.09	.01	
Physical activity (YPAS) [a]	.00	.00	.12	.00	
Number of clubs	-.61	.60	-.03	.31	
Hours out of home	1.51	.32	.17	.00	

(Table 4, continued)

Health outcomes	B	SE B	β	*P*	R^2
Satisfaction with social support	1.46	.52	.09	.01	
Model 4 (Demographics, Physical Activity, Social Factors, Frailty)					42.7%
Age	-.15	.40	-.02	.71	
Gender	-1.15	.65	-.05	.08	
Education	.44	.26	.05	.09	
Physical activity (YPAS) [a]	.00	.00	.09	.00	
Number of clubs	-.13	.54	-.01	.81	
Hours out of home	.87	.29	.10	.00	
Satisfaction with social support	.62	.46	.04	.18	
Frailty (FI-34)	-64.13	4.65	-.54	.00	

Notes. [a]YPAS total energy expenditure score expressed as kilocalories per week.

health, Frailty-Index 34 (Kim & Jazwinski, 2015), to see if demographic and social behaviors would still hold significance in the variance of self-reported health after an objective measure was added. A linear regression with FI-34 as predictor and SF-36 PCS as outcome revealed a strong negative relationship, $F(1,730) = 495.93$, $p < 0.01$, $R^2 = .40$. Such a strong relationship may have made the earlier variables obsolete in the final model; however, once frailty was added, physical activity ($p < 0.01$) and hours out of the home ($p < 0.01$) remained significant, $F(9, 716) = 59.54$, $p < 0.01$. Age, gender, and education all lost significance in this final model. This fourth and final model accounted for a total of 42.8% of the variance in self-reported health.

FI-34 Index Scores (Objective Health). Regarding the three sociodemographic variables, age, gender, and level of education each showed significance, $F(3, 722) = 203.56$, $p < 0.01$ (see Table 5, page 40). This first model reported 45.8% of the variance in objective health status. When physical activity (YPAS EE; Dipietro, Caspersen, Ostfeld, & Nadel, 1993) was added to the model, age ($p < .01$), gender ($p < .01$), and level of education ($p = 0.02$) were all significant predictors of the variance in FI-34 responses, but physical activity itself was not ($p = 0.05$). Together, these variables were responsible for 46.1% of the variance, $F(4, 721) = 154.17$, $p < 0.01$. When the social factors were added, all prior predictors held their significance ($p < 0.05$) except for number of clubs and social organizations ($p = 0.06$) and physical activity ($p = 0.08$). Together, these variables accounted for 48.9% of the variance, $F(8, 717) = 85.89$, $p < 0.01$.

These data suggest that multiple non-health related variables outside age (social behaviors and support, gender, and level of education) remain an important part of the contribution to level of frailty in an individual and therefore the overall degree to which they are aging successfully and maximizing their healthspan.

Table 5: Multiple Regression Models with Objective Health Status as Criterion Variable

Objective health – Frailty (FI-34)					
Model 1 (Demographics)					45.8%
Age	.05	.00	.66	.00	
Gender	.02	.01	.12	.00	
Education	-.01	.00	-.07	.01	
Model 2 (Demographics, Physical Activity)					46.1%
Age	.05	.00	.64	.00	
Gender	.02	.01	.12	.00	
Education	-.01	.00	-.07	.02	
Physical activity (YPAS)[a]	-.01	.00	-.06	.05	
Model 3 (Demographics, Physical Activity, Social Factors)					48.6%
Age	.05	.00	.60	.00	
Gender	.02	.01	.10	.00	
Education	-.01	.00	-.06	.03	
Physical activity (YPAS)[a]	-.01	.00	-.05	.08	
Number of clubs	.01	.00	.05	.08	
Hours out of home	-.01	.00	-.14	.00	
Satisfaction with social support	-.01	.00	-.10	.00	

Notes. [a]YPAS total energy expenditure score expressed as kilocalories per week.

DISCUSSION

In order for one to age successfully, there is, unfortunately, no elixir or potion to take to cause a long and intertwined lifespan and healthspan. Instead, multiple factors affect both how people subjectively view themselves aging and objective, biomedical views of aging. In the present research, age and gender differences were observed in social and physical activity, and self-reported health and objective health status. These findings and their significance for current views of successful aging are discussed more fully in the paragraphs that follow.

The first aim in this study was to examine age group and gender differences in sociodemographic characteristics (cognitive and affective status, self-reported health, and educational attainment), physical and social activities, and frailty. To address this aim, we divided the sample to represent four age groups: younger (21-44 years), middle-aged (45-64 years), older (65-84 years), and oldest-old adults (85 to 101 years). Overall, younger and middle-aged adult groups were comparable on the social activity measures (number of clubs, perceived social support, hours out of home). However, middle-aged adults' physical activity score was lower than that of the younger adults ($p = 0.03$) and no different from the older adults ($p = 0.82$). Oldest-old adults' physical activity score was significantly lower than all of the other age groups (p's < 0.01), as expected. With respect to self-rated health, middle-aged adults' mean SF-36 PCS score was numerically lower than the younger adults, a marginally significant difference ($p = 0.07$). However, middle-aged adults reported a significantly greater degree of frailty than did the younger adults, consistent with the hypothesis. Together, these findings imply that middle-aged adults may be at risk for health-related problems and negative behaviors which threaten the likelihood of successful aging (e.g., Britton, Shipley, Singh-Manoux, & Marmot, 2008; Dogra & Stathokostas, 2012). An age-related increase in health problems in mid-life may possibly due to a

more sedentary lifestyle than their younger counterparts, although further research would be desirable before firm conclusions would be warranted.

With respect to the two older reference groups, the mean SF-36 PCS score for the oldest-old adults was less than that of the older adults, suggestive of a linear decline in self-reported health in later life. The more interesting aspect of these data was that age interacted with gender, where the gender difference in SF-36 PCS scores was not significant for the middle-aged and younger age groups, but a difference favoring males was evident in the two older age groups. This male protective-factor was replicated in the oldest-old group only for the FI-34 outcome ($p < 0.01$). This gender difference in physical functioning may be due to older women's increased likelihood for disabling conditions such as osteoporosis, fractures, and falls (Murtagh & Hubert, 2003). Although women statistically live longer than men, as the results support, older women are generally more frail than their male counterparts (Hubbard, 2015). The present results underscore the important role of physical function in fostering health-related quality of life in late adulthood (see also Frisard et al., 2006; Srinivas-Shankar et al., 2010).

In regards to frailty, the objective measure of health, analyses revealed a main effect of age group, with each age group differing significantly from one another. Younger adults reported significantly less frailty than middle-aged adults, while oldest-old adults reported the highest ratio of frailty followed by older-old adults. The present measure of frailty provided a comprehensive assessment of biological factors (including diseases and chronic health conditions) that affect healthy aging. Including both subjective and objective measures of health-related quality of life is imperative to truly understanding all possible factors related to successful aging. In this sample, 47.2% of participants reported a score of 50 or higher on the SF-36 PCS, indicating better than average health (Ware, 2000). In contrast, those same participants reported a mean frailty deficit of

.09, approximately 3 out of 34 health-related deficits. Only seven participants across the entire sample of 732 had frailty ratios of 0. While higher numbers of older adults believe they are successfully aging than what biomedical outcomes would suggest (Strawbridge, Wallhagen, & Cohen, 2002), in the present research we found that hours out of the home was a significant predictor of both outcomes. Future research that incorporates a longitudinal assessment would be desirable to permit inferences on the causal direction of this relationship.

Conclusion

On a broader note, the field of aging is not confined to one academic discipline; rather, successful aging research encapsulates biological, psychological, and social factors, which we assume interact vigorously with each other. An interdisciplinary approach to successful aging provides a more holistic view of the person, and thus, more generalizable information on the current state of the field.

The intellectual merit of the research portrayed successful aging from a multidisciplinary, lifespan perspective. The scope of work includes significant associations among subjective and objective measures of physical health, levels of social engagement including the oldest-old (age 85+), the fastest growing segment of the population (Ortman, Velkoff, & Hogan, 2014). Using models of successful aging, the broader impacts and implications of this research can be used to improve socialization and physical activity programs for retirement and senior centers as the number of successfully aging elderly people needing their services will skyrocket in the upcoming years. In accordance with Baltes and Baltes (1990), successful aging occurs when older adults select or limit their activities and obligations to better meet demands, optimize the chosen activities to maximize gains and minimize losses, and compensate for age-related losses by using strategies. The highest-functioning older adults are ones who utilize the SOC model themselves

without prompting; however, retirement and nursing homes could provide interventions and programs that incorporate selection, optimization, and compensation in domains such as health-related quality of life, physical activity and exercise, and social engagement in order for residents to maximize their individual healthspans.

The present findings should be considered in light of at least three limitations. First, these data are based on a cross-sectional design, so inferences about the directionality of effects are not warranted. Second, we did not have an objective measure of physical activity; future studies should utilize both a self-report measure such as the YPAS alongside accelerometry to better characterize objective physical activity. Third, we did not include a measure of lifetime stress or biological indicators of healthy aging. One potentially important direction for future research would be to consider a boarder assessment of psychosocial variables that may impact heath. Additional research to examine the role of genetic factors would also provide insight into biological variables that may inevitably thwart healthy aging (Kim & Jazwinski, 2015), an exciting possibility that awaits future research**.**

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APPENDICES

Appendix A: List of 34 Variables Used to Construct Frailty-Index 34

FI34.No.	Name	Description	Numeric code
1	adrdz	You've been told that you have an adrenal disease	0, 1
2	anemia	You've been told that you have anemia	0, 1
3	angina	You've been told that you have angina	0, 1
4.	asthma	You've been told that you have asthma	0, 1
5	balance	Standing for 10 sec. with one foot behind the other	0, 1[a]
6	bathing	You need assistance when bathing	0, 1
7	bmi	Body mass index (BMI)	0, 0.5, 1[b]
8	bronch	You've been told that you have bronchitis	0, 1
9	cataracts	You've been told that you have cataracts	0, 1
10	chair	Number of stand-ups from chair without using arms	0, 1[c]
11	conghrtf	You've had congestive heart failure	0, 1
12	copd	You've been told that you have COPD	0, 1
13	diabetes	You've been told that you have diabetes	0, 1
14	dressing	You need assistance when dressing	0, 1
15	emphy	You've been told that you have emphysema	0, 1
16	feeding	You need assistance when eating	0, 1
17	fhoca	A first-degree relative has had cancer	0, 1
18	gds	Geriatric depression scale (GDS)	0, 0,5, 1[d]
19	hattack	You've had a heart attack	0, 1
20	hbp	High blood pressure (based on SBP and DBP readings)	0, 0.33, 0.66, 1[e]
21	hchol	You've been told that you have high cholesterol	1.00
22	hhbp	You have had high blood pressure before	0, 1
23	hrtmur	You've been told that you have a heart murmur	0, 1
24	hrtprb	You've been told that you have a heart problem	0, 1
25	kidndz	You've been told that you have a kidney disease	0, 1
26	liverdz	You've been told that you have a liver disease	0, 1
27	mmse	Mini-mental state exam (MMSE)	0, 0.25, 0.5, 0.75, 1[f]
28	osteo	You've been told that you have osteoporosis	0, 1
29	seiz	You've had a seizure	0, 1
30	selfrated	Self-rating of health	0, 0.25, 0.5, 0.75, 1[g]
31	stroke	You've had a stroke	0, 1
32	thydz	You've been told that you have a thyroid disease	0, 1
33	tia	You've had a TIA	0, 1
34	urininf	You've been told that you have a urinary infection	0, 1

Notes: Taken from Kim and Jazwinski (2015). COPD/copd, chronic obstructive pulmonary disease; SBP, systolic blood pressure; DBP, diastolic blood pressure; tia/TIA, transient ischemic attack. All binary variables were coded numerically: '0' for the absence of the deficit and '1' for its presence except where noted otherwise:

[a] 0 if balanced for 10 seconds, otherwise, 1;

[b] 0 if $18.5 \leq x < 25$, where x=weight (kg)/(height in meters)2, 0.5 if $25 \leq x < 30$, otherwise, 1;

[c] 0 if one can stand up from chair at least once, otherwise 1;

[d] 0 if $0 < x \leq 5$, where x is the final score of the test, 0.5 if $6 < x \leq 10$, 1 if $x > 10$;

[e] 0 if $x < 80$ and $y < 120$, where x=diastolic pressure and y=systolic pressure, 0.33 if $80 \leq x \leq 89$ or $120 \leq y \leq 139$, 0.66 if $90 \leq x \leq 99$ or $140 \leq y \leq 159$, 1 if $x \geq 100$ or $y \geq 160$. This coding is based on the categories of blood pressure levels according to the National Heart Lung and Blood Institute;

[f] 0 if $24 \leq x$, where x is the final score of the test, 0.25 if $20 < x < 24$, 0.5 if $18 \leq x \leq 20$, 0.75 if $10 \leq x \leq 17$, and 1 if $x < 10$;

[g] 0 = Excellent, 0.25 = Very good, 0.5 = Good, 0.75 = Fair, 1 = Poor

Appendix B: List of Questions Used to Construct the Yale Physical Activity Survey Weekly Energy Expenditure Scores

Activity	Time		Intensity Code
	Hours	Minutes	
House Work			
Offline Shopping (e.g., grocery, clothes)			3.5
Stair climbing while carrying a load			8.5
Laundry – Unloading/loading machine, hanging, folding only			3.0
Laundry – Washing clothes by hand			4.0
Light housework (e.g., tidying, dusting, ironing, sweeping)			3.0
Heavy housework (e.g., vacuuming, mopping, scrubbing floors and walls, moving furniture)			4.5
Food preparation: chopping, stirring, moving about while cooking/baking			2.5
Food service: Setting table, carrying food, serving food			2.5
Dish washing: clearing the table, washing/drying dishes, putting dishes away			2.5
Light home repair: small appliance repair, light home repair			3.0
Heavy home repair: painting, carpentry, washing/polishing car			5.5
Other:			
Yard Work			
Gardening, pruning, planting, weeding, digging, hoeing			4.5
Lawn mowing (walking only)			4.5
Clearing walks/driveways: sweeping, shoveling, raking			5.0
Other:			
Caretaking			
Older or disabled person (lifting, pushing wheelchair)			5.5
Child care (lifting, carrying, pushing stroller)			4.0
Exercise			
Brisk walking			6.0
Pool exercises, stretching, yoga			3.0
Vigorous calisthenics, aerobics			6.0
Cycling			6.0
Swimming (laps only)			6.0
Other:			
Recreation	Hours	Minutes	Intensity Code
Leisurely / slow walking			3.5
Needlework: knitting, sewing, needlepoint, etc.			1.5
Dancing: line, ballroom, tap, square, etc.			5.5
Bowling			3.0
Golf			5.0
Racquet sports: tennis, squash, badminton			7.0
Billiards			2.5
Other:			
Notes: Taken from Dipietro, Caspersen, Ostfeld, & Nadel, 1993.			

Appendix C - List of questions used to construct the Medical Outcomes Study Questionnaire Short Form 36 Health Survey (from Ware & Sherbourne, 1992; Ware, 2000)

Medical Outcomes Study Questionnaire Short Form 36 Health Survey

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Thank you for completing this survey! For each of the following questions, please circle the number that best describes your answer.

1. In general, would you say your health is:	
Excellent	1
Very good	2
Good	3
Fair	4
Poor	5
2. Compared to one year ago,	
Much better now than one year ago	1
Somewhat better now than one year ago	2
About the same	3
Somewhat worse now than one year ago	4
Much worse now than one year ago	5

3. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?
(Circle One Number on Each Line)

	Yes, Limited a Lot (1)	**Yes, Limited a Little (2)**	**No, Not Limited At All (3)**
a. **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	1	2	3
b. **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing Golf	1	2	3
c. Lifting or carrying groceries	1	2	3

d. Climbing **several** flights of stairs	1	2	3
e. Climbing **one** flight of stairs	1	2	3
f. Bending, kneeling, or stooping	1	2	3
g. Walking **more than a mile**	1	2	3
h. Walking **several blocks**	1	2	3
i. Walking **one block**	1	2	3
j. Bathing or dressing yourself	1	2	3

4. During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of your physical health**?
(Circle One Number on Each Line)

	Yes (1)	**No (2)**
a. Cut down the amount of time you spent on work or other activities	1	2
b. **Accomplished less** than you would like	1	2
c. Were limited in the **kind** of work or other activities	1	2
d. Had **difficulty** performing the work or other activities (for example, it took extra effort)	1	2

5. During the **past 4 weeks,** have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?
(Circle One Number on Each Line)

	Yes	**No**
a. Cut down the amount of time you spent on work or other activities	1	2
b. **Accomplished less** than you would like	1	2
c. Didn't do work or other activities as **carefully** as usual	1	2

6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?	
Not at all	1
Slightly	2
Moderately	3
Quite a bit	4
Extremely	5

7. How much bodily pain have you had during the past 4 weeks?	
None	1
Very mild	2
Mild	3
Moderate	4
Severe	5
Very severe	6
8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?	
Not at all	1
A little bit	2
Moderately	3
Quite a bit	4
Extremely	5

These questions are about how you feel and how things have been with you **during the past 4 weeks**. For each question, please give the one answer that comes closest to the way you have been feeling. **(Circle One Number on Each Line)**

9. How much of the time during the **past 4 weeks** . . .

	All of the Time	**Most of the Time**	**A Good Bit of the Time**	**Some of the Time**	**A Little of the Time**	**None of the Time**
a. Did you feel full of pep?	1	2	3	4	5	6
b. Have you been a very nervous person?	1	2	3	4	5	6
c. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
d. Have you felt calm and peaceful?	1	2	3	4	5	6
e. Did you have a lot of energy?	1	2	3	4	5	6

	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	None of the Time
f. Have you felt downhearted and blue?	1	2	3	4	5	6
g. Did you feel worn out?	1	2	3	4	5	6
h. Have you been a happy person?	1	2	3	4	5	6
i. Did you feel tired?	1	2	3	4	5	6

10. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)? (Circle One Number)	
All of the time	1
Most of the time	2
Some of the time	3
A little of the time	4
None of the time	5

11. How TRUE or FALSE is each of the following statements for you. (Circle One Number on Each Line)

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
a. I seem to get sick a little easier than other people	1	2	3	4	5
b. I am as healthy as anybody I know	1	2	3	4	5
c. I expect my health to get worse	1	2	3	4	5
d. My health is excellent	1	2	3	4	5

Notes: Taken from McHorney, C. A., Ware, J. E., Lu, J. F. R., & Sherbourne, C. D. (1994).

VITA

Katie E. Stanko is a third year student in the Cognitive and Brain Sciences doctoral program at Louisiana State University, Baton Rouge, Louisiana. She received her bachelor's degrees in psychology and criminology from Indiana University of Pennsylvania, Indiana, Pennsylvania, in 2014. Her research interests include successful aging, older adults' response to long-term stress, trauma, and disaster, and cognitive epidemiology.